Measurement of Greenhouse Gas Emissions from Dairy Farms in California

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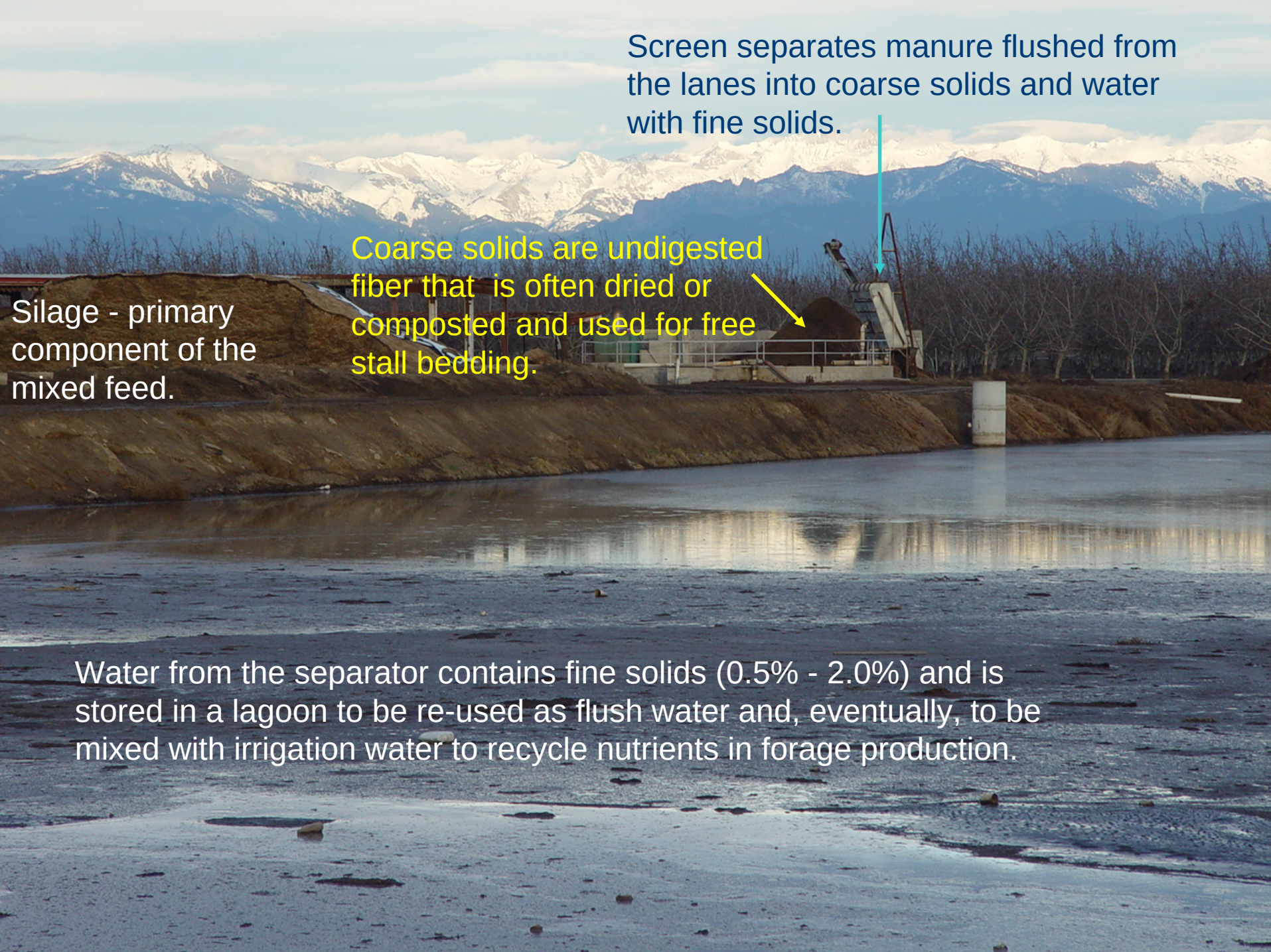
Research Sponsors

- Primary funding from CARB-Research Division for speciation of ozone precursors related to dairy operations
- Secondary funding from U New Hampshire (USDA and CEC) for monitoring of N compounds, including GHG, related to dairy operations.
- Secondary funding from UC Davis (USDA) for monitoring of alcohols related to dairy feeding.
- Matching funding from the CSU-Agriculture Research Initiative for staff, equipment and other support related to the CARB, UNH and UCD projects.
- Additional projects conducted at the six dairy sites:
  - Photosynthetic lagoon emissions
  - Ammonia emissions monitoring using TDL
  - Emissions from composting of dairy solids

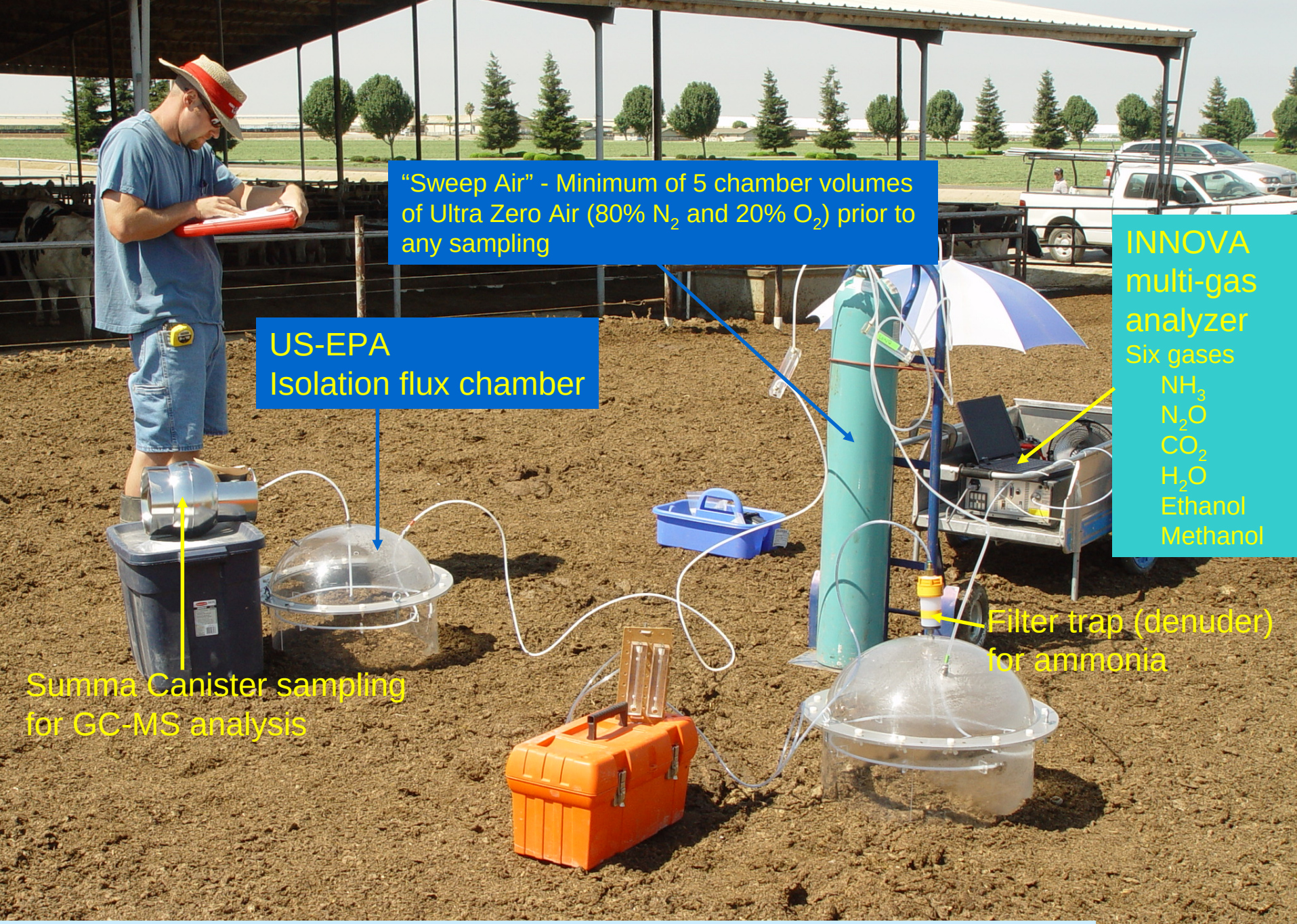
Dairy B: A “typical” free stall, flush lane operation


Screen separates manure flushed from the lanes into coarse solids and water with fine solids.
Coarse solids are undigested fiber that is often dried or composted and used for free stall bedding.
Silage - primary component of the mixed feed.
Water from the separator contains fine solids (0.5% - 2.0%) and is stored in a lagoon to be re-used as flush water and, eventually, to be mixed with irrigation water to recycle nutrients in forage production.

Sampling ROG's, N_2O and NH_3 from a silage pile with flux chambers at Dairy D

Sampling ethanol, methanol, ammonia, N_2O and ROG's from Total Mixed Ration (TMR) using flux chambers at Dairy A.

Flux Chamber monitoring of flush lane at Dairy B



Exercise corral receives 25% - 40% of the manure, depending on weather.

Field data to reported results

- Sampling from the flux chamber provides a concentration value in ppm, $\mu g/M^3$ or mg/Kg that should NOT be confused with ambient values.
- The concentration from the flux chamber is converted to a flux in $\mu g/M^2$/minute by:
  - Converting ppmV to $\mu g/M^3$, if necessary, with the molecular wt. and various conversion factors
  - Converting $\mu g/M^3$ to $\mu g/M^2$/minute flux with the sweep air Q and area covered by the chamber.

$N_2$0-N Fluxes from Six Dairies Sampled July, '06 through February, '07

Dairy Flux Averages						Manure Analysis						
				NH_3-N	N_2O-N			TN	NH4	NO3	OM	Moisture
Dairy-Month	# Loc.	Source	Date	ug m^{-2} min^{-1}		Comments	Description	%	mg/kg	mg/kg	%	%
B-July	4	Open Lot	7/12/2006	1821	**21**		deep pack (4)	2.6	171	101	66	22
F-July	4	Open Lot	7/28/2006	606	**28**		dp, shl, (4)	2.3	295	36	57	6
C-Aug.	4	Open Lot	8/9/2006	424	**24**		wet (4)	1.8	131	18	47	26
B-Sept.	4	Open Lot	9/19/2006	3749	**17**		dp, shl, urn. (4)	2.6	1963	22	68	50
A-Oct.	3	Open Lot	10/2/2006	472	**40**	**Urine patch flux = 88**	dp, shl, urn. (3)	3.1	516	713	70	39
E-Nov.	2	Open Lot	11/7/2006	442	**11**		ave. (2)	2.4	188	15	70	31
D-Nov.	4	Open Lot	11/14/2006	626	**99**	**Urine patch flux = 180**	dp, shl, urn. (4)	3.0	2896	221	81	48
F-Dec.	2	Open Lot	12/4/2006	237	**4**		ave. (2)	2.2	531	7	52	30
C-Jan.	4	Open Lot	1/12/2007	149	**5**		dp, shl, (4)	2.0	188	34	41	42
A-Jan.	4	Open Lot	1/25/2007	62	**5**		dp, shl, (4)	2.6	171	1120	59	36
E-Feb.	2	Open Lot	2/1/2007	208	**0**		ave. (2)	1.8	497	2	56	58
AVERAGE for Exercise Corrals				800	**23**			**2.4**	**686**	**208**	**61**	**35**
B-July	2	FL-Pre Flush	7/12/2006	1938	**1**			2.3	9228	31	82	54
F-July	2	FL-Pre Flush	7/28/2006	2967	**0**			2.6	8038	45	88	86
C-Aug.	2	FL-Pre Flush	8/9/2006	193	**6**			2.3	1514	86	73	87
B-Sept.	2	FL-Pre Flush	9/20/2006	1562	**2**			2.6	132923	1		89
A-Oct.	2	FL-Pre Flush	10/2/2006	226	**5**			3.0	421	43	86	87
D-Nov.	2	FL-Pre Flush	11/13/2006	519	**0**			2.8	3421	160		83
F-Dec.	2	FL-Pre Scrape	12/4/2006	286	**0**			3.0	1350	16	87	86
C-Jan.	2	FL-Pre Flush	1/12/2007	221	**3**			2.8	12417	28	85	88
A-Jan.	2	FL-Pre Flush	1/25/2007	171	**0**			2.3	610	2	68	84
E-Feb.	2	FL-Pre Vac	2/1/2007	453	**0**			2.4	4628	15	77	48
AVERAGE for Flush Lanes				854	**2**			**2.4**	**686**	**208**	**61**	**35**
E-Nov.	1	Digested Solids Pile-Old	11/7/2006	4066	**72**							
E-Feb.	1	Fan Separator Pile	2/1/2007	1863	**8**							
B-Sept.	1	Scraped Manure Pile	9/19/2006	11973	**855**							
F-Dec.	1	Separated Solids Pile	12/4/2006	24	**13**							
AVERAGE for Separated Solids				4482	**237**							

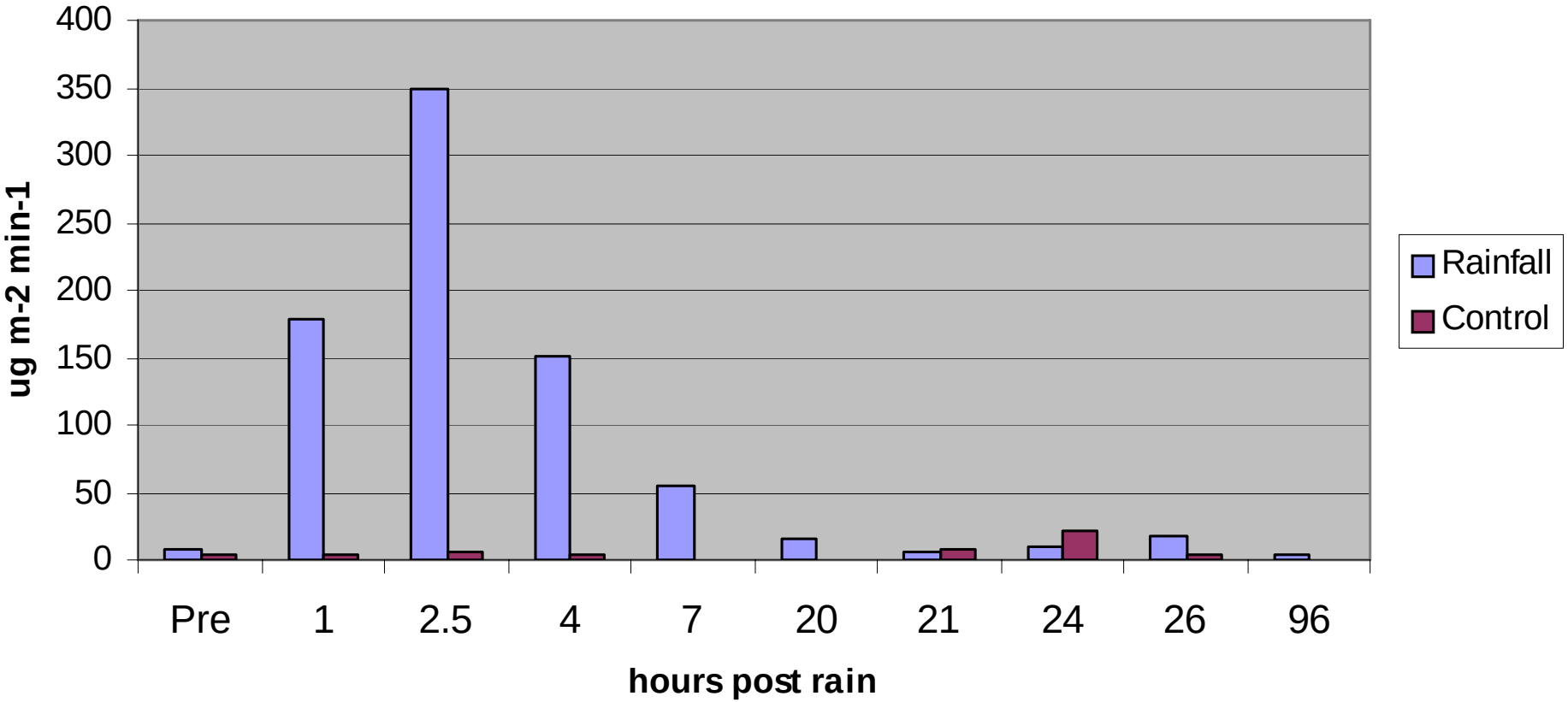
N2O Flux	**$\mu g\ m^{-2}\ min^{-1}$**
Spring, 2007	
Silage	17.1
Feed	6.0
Corral	13.1
pre-Flush	0.8
Post-Flush	1.7
Bedding	3.1

N_20-N Fluxes from Six Dairies Sampled May-June, ’07

Corral values are lower than the previous fall/winter samples from the same dairies, probably due to lower moisture conditions.

(very) Preliminary Conclusions

- N_2O emissions at dairies are related to:
  - High oxidized N compounds
  - Low aeration conditions
  - High moisture conditions
- Short term “spikes” of N_2O may occur when these conditions are initially obtained.



A simulated rain event of 20mm was applied with a sprinkler to the exercise corral manure pack that had been deposited over the summer. A spike of N_2O emissions was expected due to the accumulated oxidized N compounds being suddenly exposed to low O_2 conditions from saturating the previously aerated pack with rain water.

Questions ?

Dairy C: secondary lagoon with circulator

Land Application of Lagoon Effluent at Dairy D (June, 2006)